

FIG.1

Derivation of numerical data of minutia ridge shape

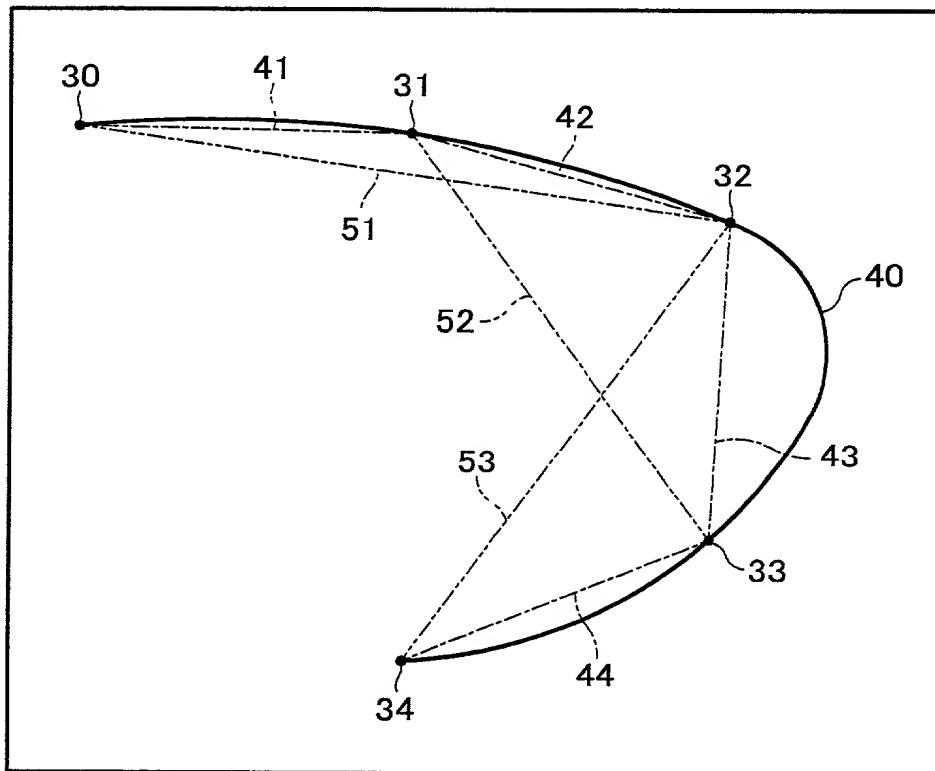


FIG.2

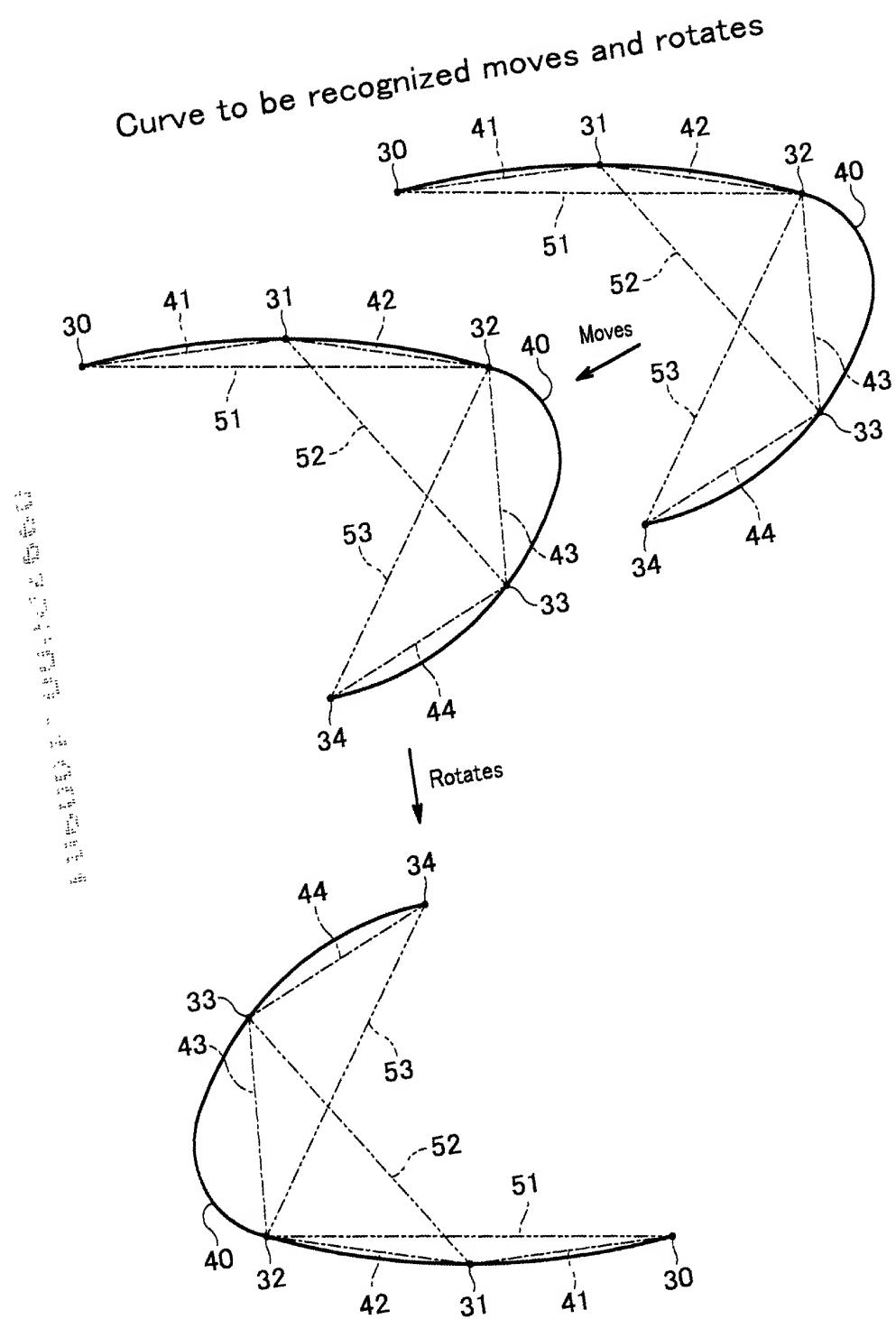


FIG.3

Principle to calculate approximately coordinates of measure points, which locates between grids

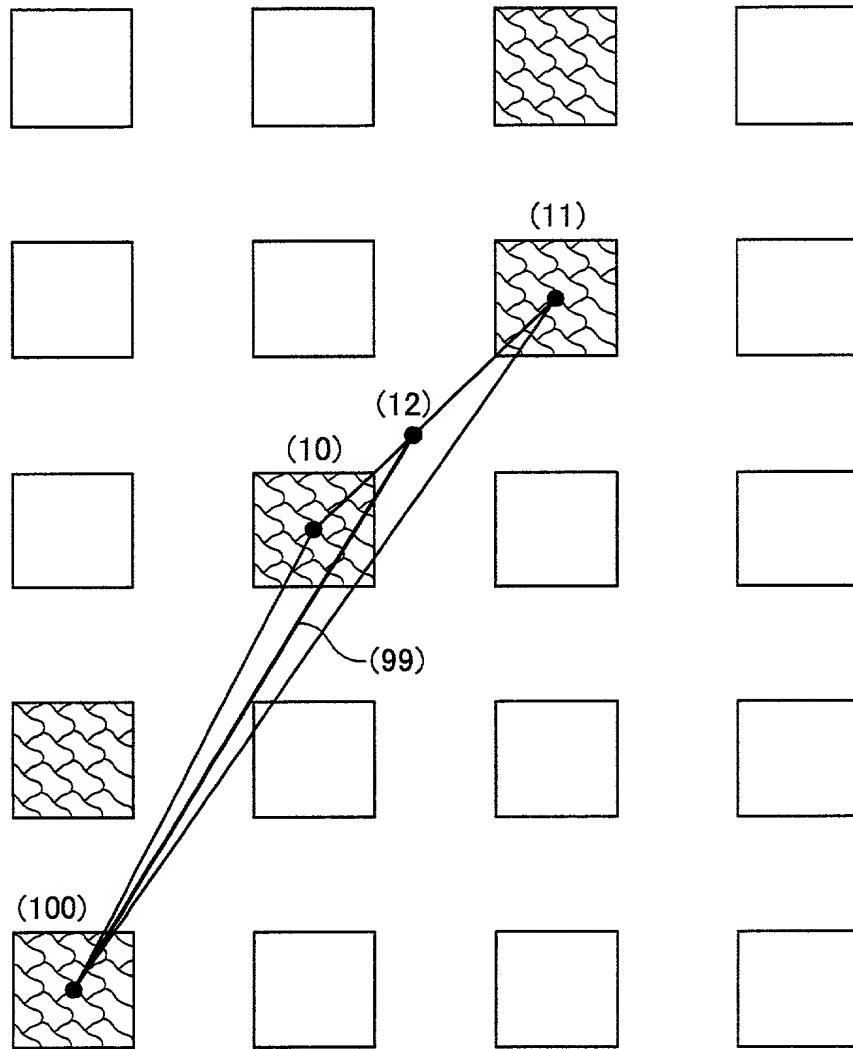


FIG.4

Curve shape system using curvature and ridge direction

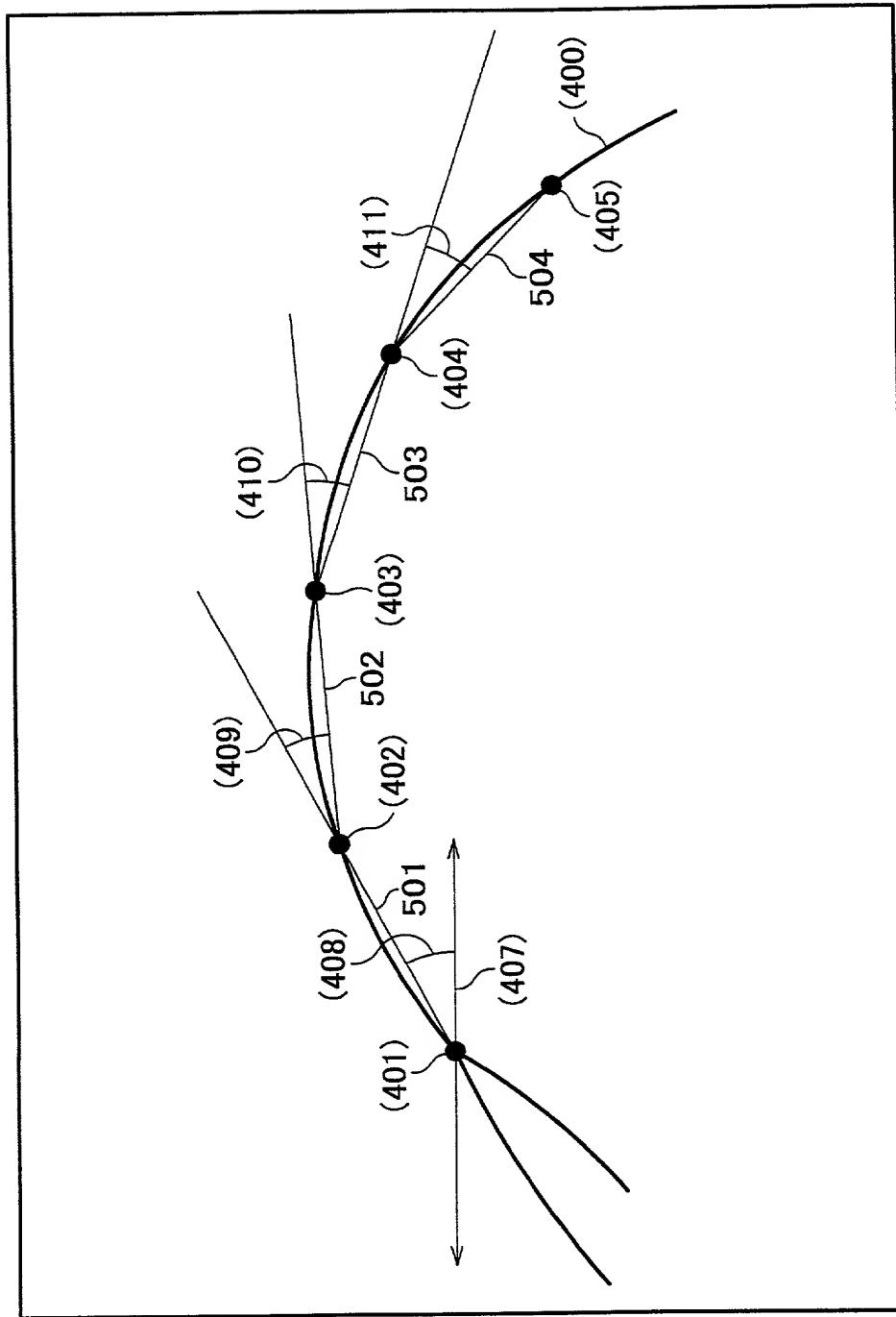


FIG.5

Algorithm for extraction of extract true minutia  
thinning operation and reverse operation between black and  
white over black and white binary image  
Input original black and white image

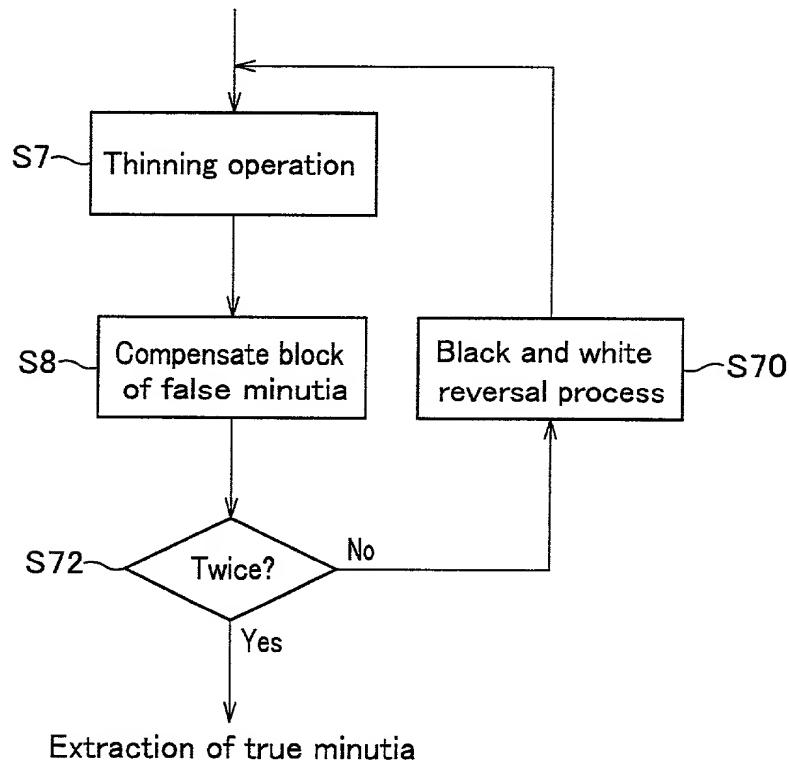


FIG.6

Algorithm for extraction of true minutia including improvement of gray scale image

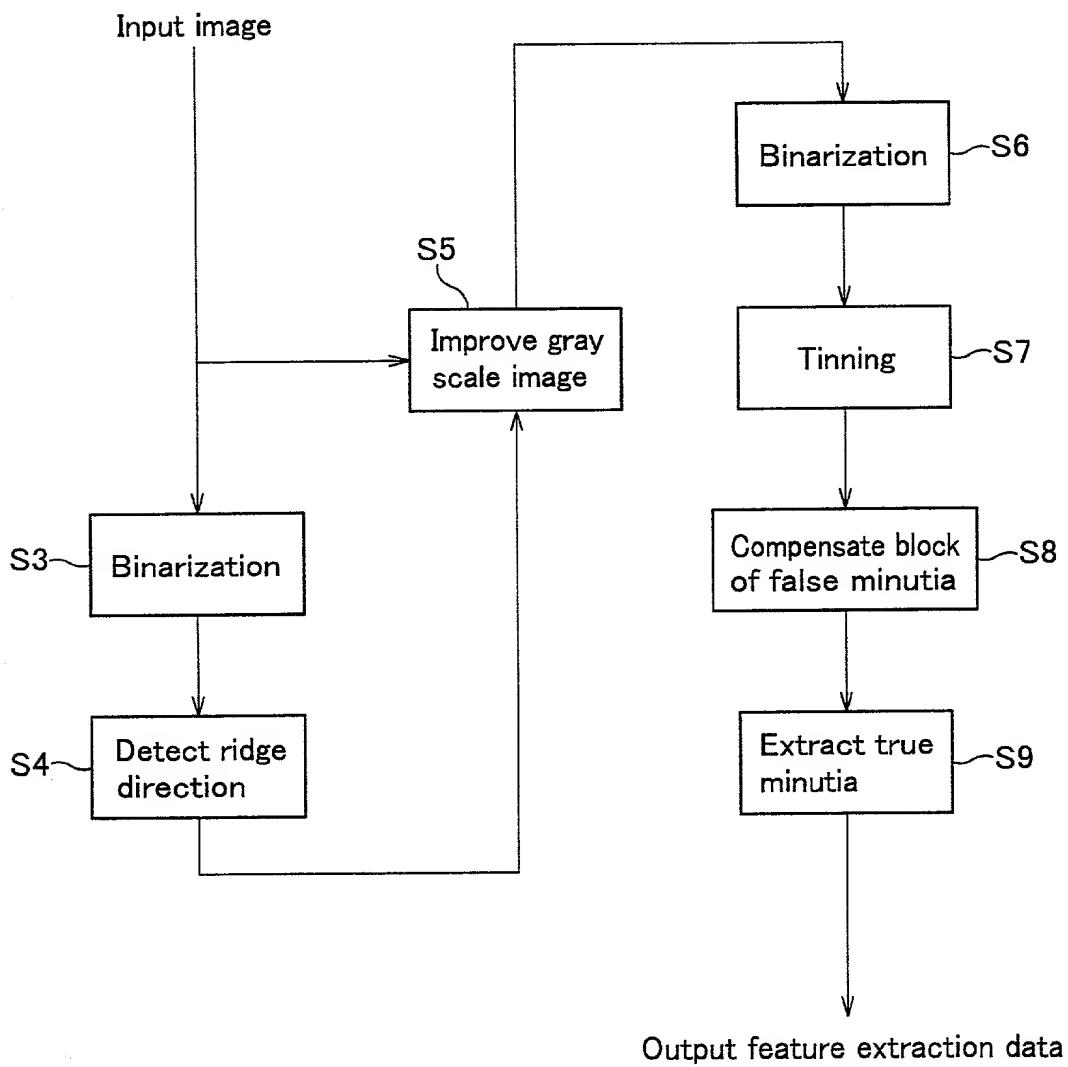
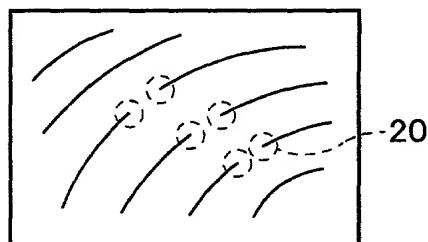


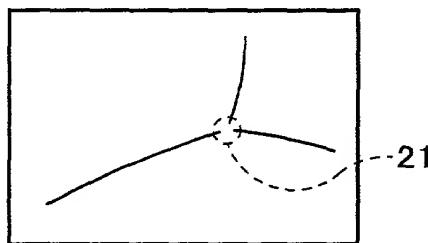
FIG.7

### False feature point

(a) Two ending minutia close to each other, which posses the same directions as their minutia ridge shapes



(b) Ending minutia near a bifurcation point



(c) Ending minutia near boundary of image

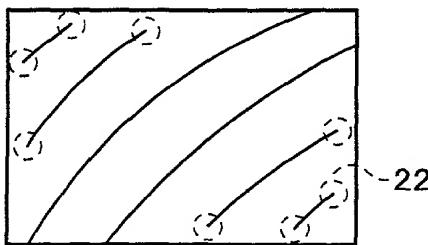


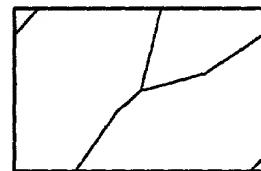
FIG.8

Extraction of minutia by thinning and reverse operations  
between black and white over black

(a) Black and white image  
before treatment



(b) Intermediate extracted minutia



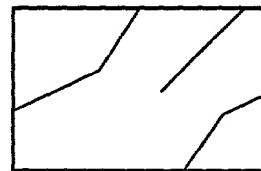
Tinning

Reverse operation

(c) Black and white reversal image



(d) Extracted minutia after  
final treatment



Tinning

FIG.9

## System for fingerprint authentication with secondary feature

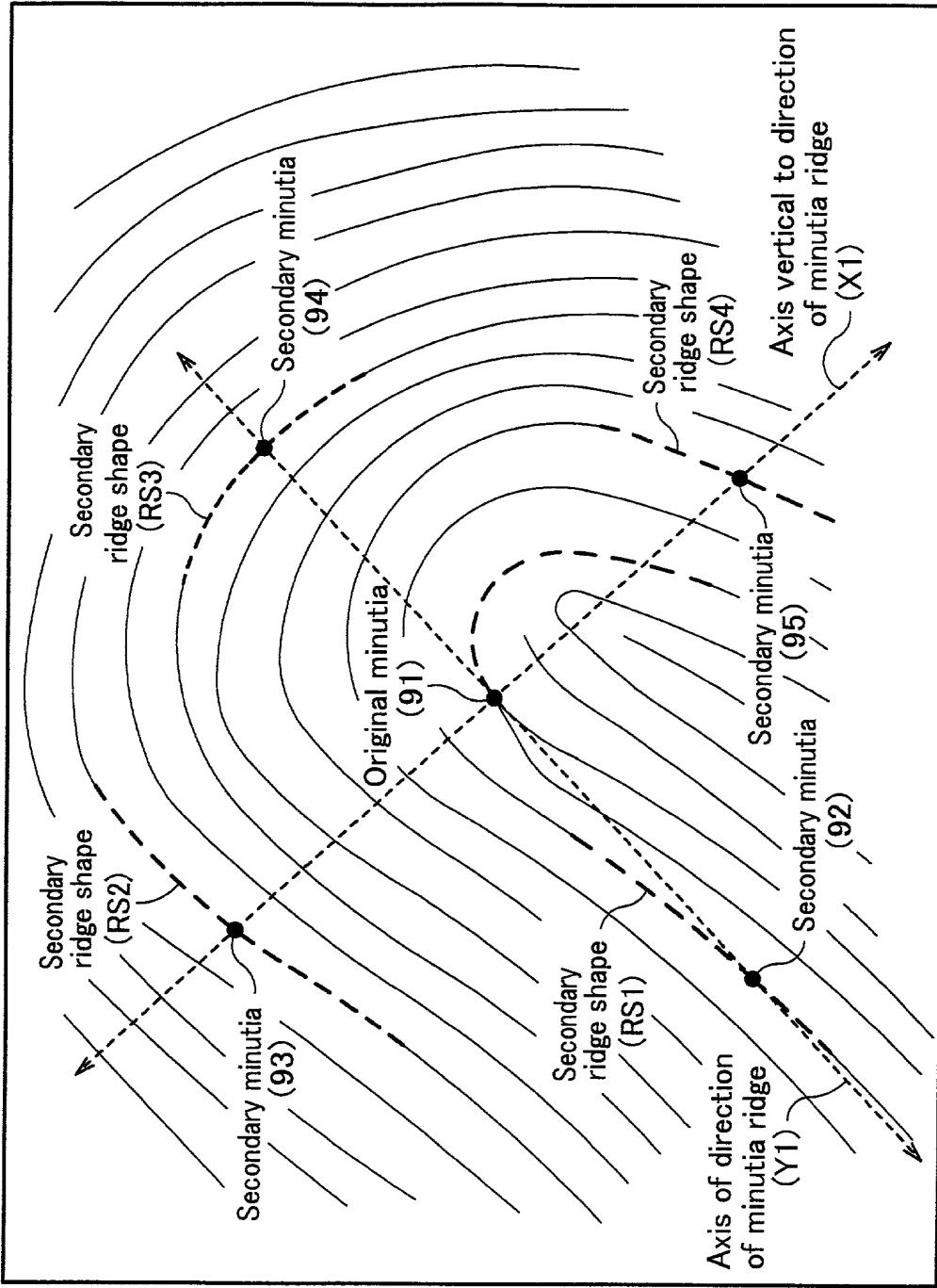


FIG.10

Judgment of removal of false  
minutia utilizing scalar product

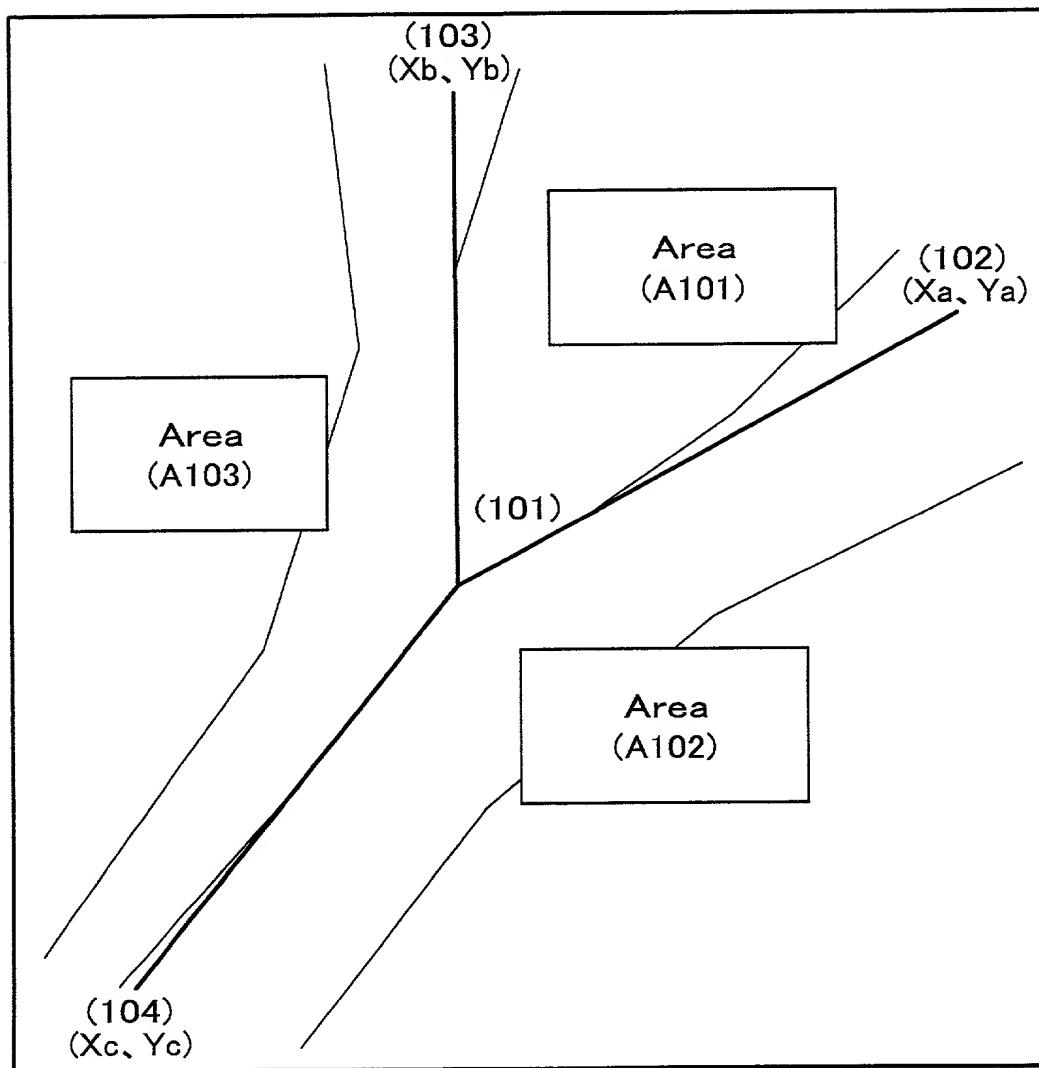


FIG.11

Memory area stores accumulated similarity measure in collation without compensation of difference of minutia pair in positions

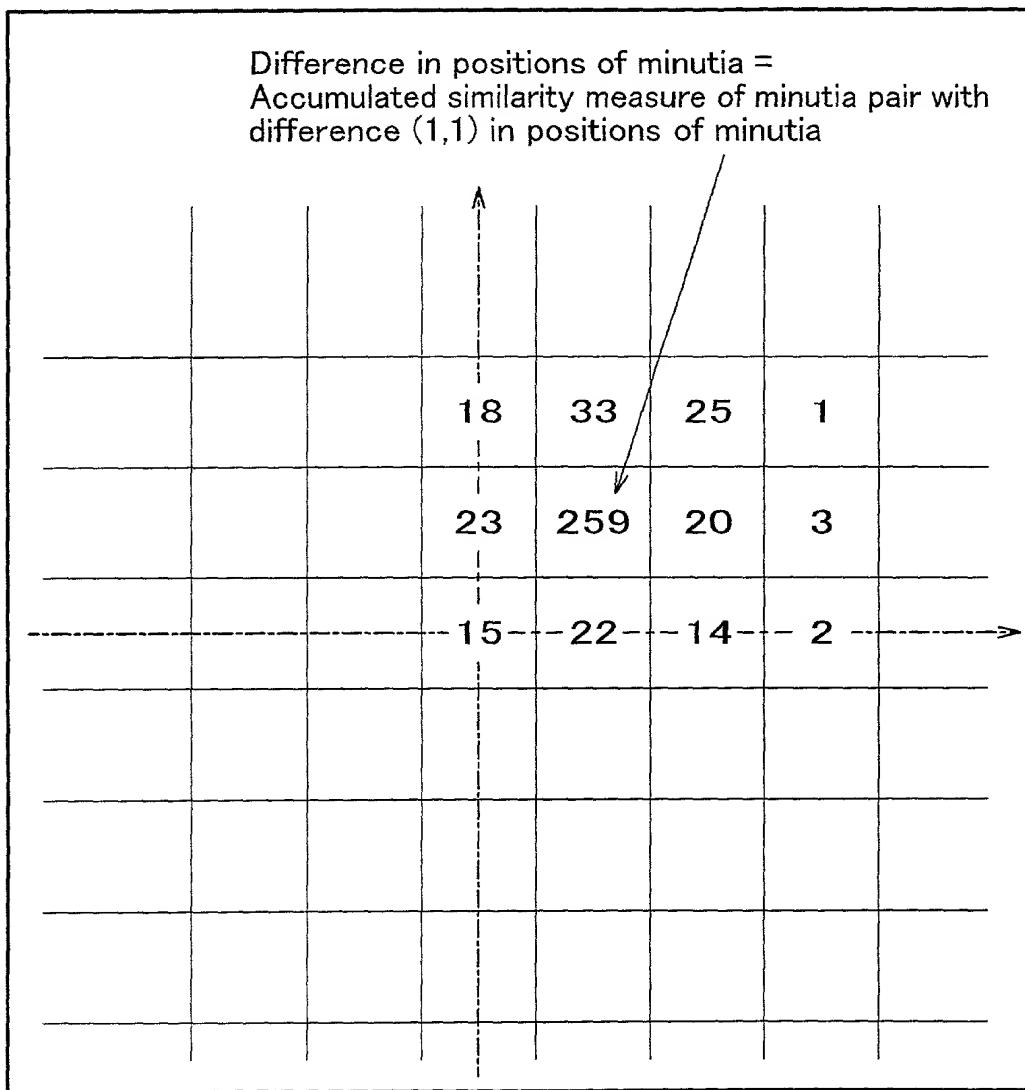


FIG.12

Algorithm of feature extraction for recognition system by use of raster scan image capture

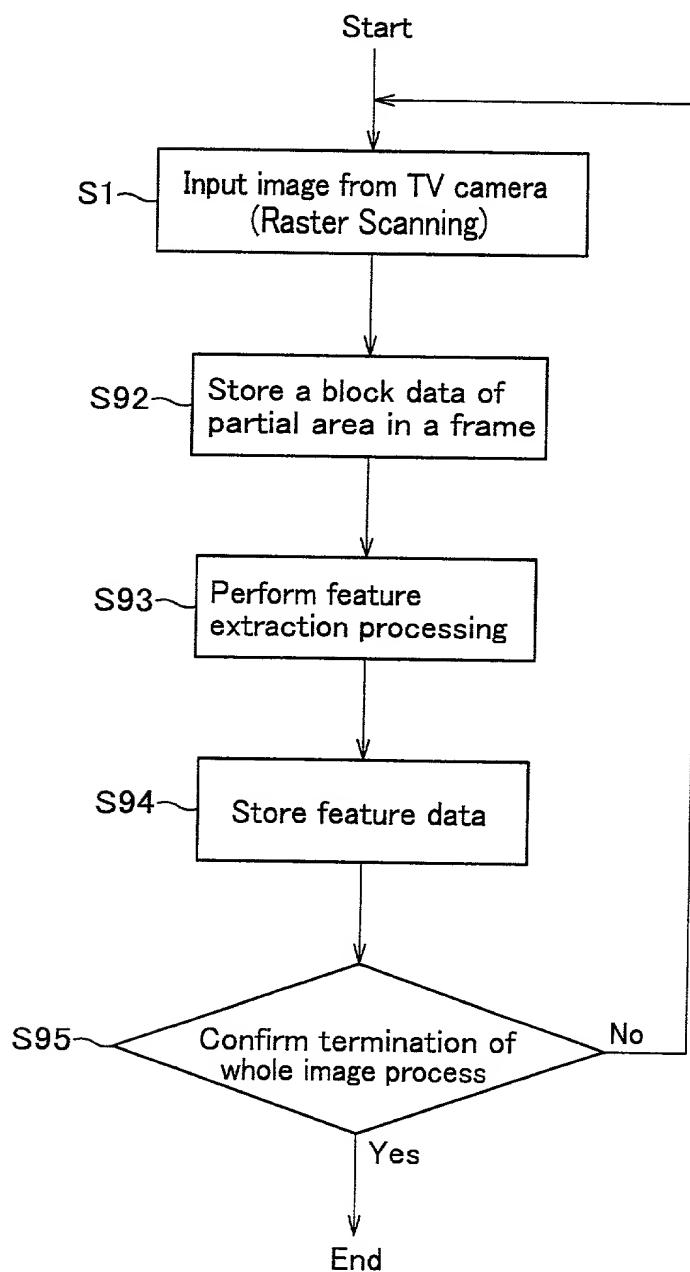


FIG.13

Algorithm for finger authentication system

